REPORT DOCUMENTATION PAGE

Form Approved OMB NO. 0704-0188

The public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggesstions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA, 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any oenalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.
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1. REPORT DATE (DD-MM-YYYY)	2. REPORT TYPE	3. DATES COVERED (From - To)
10-08-2017	Final Report	5-Jul-2011 - 5-Jul-2012

4. TITLE AND SUBTITLE
Final Report: Casablanca International Workshop in Mathematical Biology: Control and Analysis

5a. CONTRACT NUMBER
W911NF-11-1-0244

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER
0620BE

6. AUTHORS

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAMES AND ADDRESSES
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8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS (ES)
U.S. Army Research Office
P.O. Box 12211
Research Triangle Park, NC 27709-2211

10. SPONSOR/MONITOR'S ACRONYM(S)
ARO

11. SPONSOR/MONITOR'S REPORT NUMBER(S)
60140-MA-CF.1

12. DISTRIBUTION AVAILIBILITY STATEMENT
Approved for public release; distribution is unlimited.

13. SUPPLEMENTARY NOTES
The views, opinions and/or findings contained in this report are those of the author(s) and should not contrued as an official Department of the Army position, policy or decision, unless so designated by other documentation.

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	15. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			Abdessamad Tridane
UU	UU	UU	UU		19b. TELEPHONE NUMBER 480-727-5005

RPPR Final Report
as of 25-Aug-2017

Agency Code:

Proposal Number: 60140MACF **Agreement Number: W911NF-11-1-0244**
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DUNS Number: 943360412 EIN: 860196696
Report Date: 05-Oct-2012 Date Received: 10-Aug-2017
Final Report for Period Beginning 05-Jul-2011 and Ending 05-Jul-2012
Title: Casablanca International Workshop in Mathematical Biology: Control and Analysis
Begin Performance Period: 05-Jul-2011 **End Performance Period:** 05-Jul-2012
Report Term: 0-Other
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Distribution Statement: 1-Approved for public release; distribution is unlimited.

STEM Degrees: **STEM Participants:**

Major Goals: This workshop was held in in Casablanca, Morocco from June 20 to June 24, 2011. This five days workshop aimed to bring together US and international scientists actively engaged in the research of mathematical biology modeling to explore opportunities for research collaborations. The workshop contributed to establish a set of research projects, and provided opportunities for future directions of the mathematical and computational modeling of diseases. A particular field of interest in Africa is the mathematical and computational modeling of communicable and non--communicable diseases

Accomplishments: The Casablanca workshop had gathered around 300 US, African and international mathematical biologists, as well as a number of systems biologists. These scientists had worked in different the mathematical modeling of infectious diseases that are related to Africa such Cholera, Malaria, HIV and within--host diseases such as cancers. The economic, demographical and environmental changes in Africa require that the modeling of these diseases must adapted to the constraint of the continent and intensive collaborative research between mathematicians and biologists..
Different mathematical and computational approaches were presented that show different path of research that help to understand the dynamic of these diseases and reduce their burdens on the African populations. In fact, the presenters proposed various mathematical model (phenomenological, deterministic and stochastic) and discuss roles of different mathematical and biological tools in finding possible control measure to contain these diseases.
Results:
The scientific program included seven plenary speakers, several parallel session contributed talks, poster session, workshop lectures by leading experts in mathematical biology and a panel discussion on mathematical biology in Africa. The topics that been presented were in mathematical modeling of emerging diseases in Africa, cancer modeling, calcium oscillation, population dynamics, signaling networks, and optimal control of diseases…, among others. The contributed talks and the poster session provided an opportunity for the participants to share their findings and reflect on possible collaborations on more challenging topics of interest to the African continent. The workshop was aimed to train the young African and local graduate students and junior faculty with some new mathematical tools including: Competition Models (Prof. Saber Elaydi, Trinity University) ecology and evolutionary biology modeling (Prof. Van Savage, UCLA), ODE and PDE cell population dynamic models (Prof. Jean Clairambault , INRIA), Modelling of Avascular Tumour (Prof. Helen Byrne, University of Oxford), Epidemic threshold R0 (Prof. Carlos Chastillo Chavez, Arizona State University). Bioeconomics (Dr. Eli Fenichel Yale University) These lectures were very fruitful for the young participants and help also to discuss some open questions and new directions of research that need more collaborative work on how to control the burden of

diseases such as cancer, vector--borne diseases, Influenza, HBV and HIV.

Training Opportunities: Nothing to Report

Results Dissemination: The results have been disseminated through publications as follow:
Impact of Neighborhood Structure on Epidemic Spreading by Means of Cellular Automata Approach B Cissé, SE Yacoubi, A Tridane Procedia Computer Science 18, 2603--2606, 2-- 13
Special issue on cancer modeling, analysis and control A Eladdadi, N Yousfi,
A Tridane Discrete and Continuous Dynamical Systems Series B (DCDS--B) 18 (4), 2013
(http://www.aimsciences.org/journals/contentsListnew.jsp?pubID=580) A Delay Virus Dynamics Model with General Incidence Rate AT Khalid Hattaf, Noura Yousfi Differential Equations and Dynamical Systems, 2012
Mathematical analysis of a virus dynamics model with general incidence rate and cure rate K Hattaf, N Yousfi, A Tridane Nonlinear Analysis: Real World Applications, 2012

Honors and Awards: Nothing to Report

Protocol Activity Status:

Technology Transfer: Nothing to Report

Final report:
Army research office

The Army research office has granted at proposal to support the "Casablanca International Workshop in Mathematical Biology: Control and Analysis" This international event aimed to present the latest scientific progress in the field of Mathematical Biology, particularly disease modeling for endemic and emerging diseases in Africa. This event together a total of 300 participants from different part of the world including US, African countries, Europe and MENA region. Two of main organizers were women and a total of 27 women, two of whom were plenary speakers, participated in the meeting.

Website of the conference: https://sites.google.com/a/asu.edu/cicwmb/
Full program :
https://docs.google.com/viewer?a=v&pid=sites&srcid=YXN1LmVkdXxjaWN3bWJ8Z3g6NTFhZTY3MGFiMmQxZmM3

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A Delay Virus Dynamics Model with General Incidence Rate AT Khalid Hattaf, Noura Yousfi Differential Equations and Dynamical Systems, 2012

Mathematical analysis of a virus dynamics model with general incidence rate and cure rate K Hattaf, N Yousfi, A Tridane Nonlinear Analysis: Real World Applications, 2012

Workshop Name:	Casablanca International Workshop on Mathematical Biology: Control & Anaysis
Location & Date:	Morocco, June 20-24, 2011
Co-Chairs:	Abdessamad Tridane & Amina Eladdadi
Number of Expected Participants not eligible for Financial Support:	60
Number of Days	5

Workshop Expenses:	**Cost/day**	**Total Cost (Cost/day * # of days * headcount)**
Workshop Site & Meals	$20.00	$6,000
Rooms	$80.00	$24,000
Transportation (Local)	$25.00	$7,500
Printing & Supplies	$10.00	$3,000
WiFi and Hall-PCs lease	$10.00	$3,000
Total Expenses		**$43,500**

Receipts:	
NSF (Pending-Will be spent on 25 participants +overhead)	
SMB (approved)	
Workshop fees received	
Other Income	
Total:	

Net Income	

Estimation and allocation of the participants	Category	Number
	Regular	40
	Graduate & undergraduate students	20
	African Regular & African Students	40
	Total registration income	

$49,900.00

$2,000.00

#VALUE!

$2,500.00

#VALUE!

#VALUE!

Income

$10,000.00

$1,000.00

$0.00

#VALUE!

Casablanca International Workshop on Mathematical Biology: Control and Analysis Casablanca, Morocco

Sarah Olson and Vivi Andasari
(Edited and submitted by Amina Eladdadi & Abdessamad Tridane)

Casablanca International Workshop on Mathematical Biology was held in Casablanca, Morocco from June 20-24, 2011, and was hosted at the University of Hassan II (Mohammed Sekkat library and Ben M'Sik Campus). The workshop was organized by Drs. Abdessamad Tridane, from Arizona State University, Amina Eladdadi from The College of Saint Rose NY, and Noura Yousfi from University of Hassan II, Faculty of Sciences Ben M'Sik, Casablanca, Morocco. This international meeting drew over 200 participants from all over the world.

The organizers put together an impressive scientific and social program. The social program was no doubt the highlight of the Casablanca International workshop, which made it a delightful, pleasant and unforgettable experience for all of the attendees. The scientific program included a mixture of plenary and workshop lectures by leading experts in Mathematical Biology, contributed talks by junior scientists, a round table, and a poster session. A total of eighty talks and thirty-five posters were presented. They covered a wide range of topics in mathematical biology including modeling of emerging diseases in Africa, cancer modeling, calcium oscillation, population dynamics, and signaling networks, control theory, among others. The plenary speakers included Helen Byrne, Carlos Castillo-Chavez, Jean Clairambault , Saber Elaydi, Abdelhaq El-Jai, Urszula Ledzewick, and James Sneyd.

Following the opening remarks by the Chancellor of University Hassan II, and the workshop co-chairs, Prof. Carlos Castillo-Chavez of Arizona State University kicked-off the plenary lectures with his talk, "Open challenges and opportunities in mathematical epidemiology." His talk emphasized that there exists a 'shifting paradigm' as more diseases emerge and resurge. Current modeling efforts use standard SIR models as well as agent based models in order to understand and capture the spread of disease in cities, feasibility and effectiveness of responses, cross immunity, and movement of people via transportation. In order to relate these concepts to common parameters in SIR models, such as the basic reproductive number, there must be an understanding of the coupling between different scales. Another take home message of the talk was that with resurging diseases, each epidemic changes the landscape of the immunity across each country. This excellent talk initiated a great start to the conference, highlighting how mathematical models in epidemiology have had success in the past and that there are many open questions for young researchers to study in the future. The second plenary talk of the first day of the conference was given by Prof. Saber Elaydi from Trinity University. This lively talk gave an overview of the theory of nonautonomous dynamical systems. Throughout the mathematical description of the equations, he emphasized the incorporation of periodicity into these equations. In terms of biological modeling, this periodicity could be in terms of the four seasons, for example. For periodically forced dynamical systems, attenuance and resonance were discussed.

Prof. Abdehalq El Jai, from the University of Perpignan, France opened the second day of the workshop with the plenary talk on "Modelling and Analysis of Distributed Parameter Systems (DPS):

Prof. Carlos-Castillo Chavez giving his plenary talk

Approaches Motivated by Real World Problems." He gave an immaculate overview and talked about the history of the systems theory. He then went on to explain the complexity of the DPS modeling due to input space variables and its analysis. Prof. El-Jai also talked about some the DPS applications such as vegetation dynamics, ecosystems, water cycle, and meteorology.

After the scrumptious morning break that included the most delectable Moroccan sweets and the famous Moroccan mint tea and spiced coffee, Prof. Urszula Ledzewicz from Southern Illinois University gave the second plenary talk on the "Analysis of Multi-input Optimal Control Problems for Combination Therapies of Cancer." In her talk, she presented the application of optimal control methods to design optimal protocols for models of various types of multi-treatments for cancer: Tumor Anti-Angiogenesis, Combinations of Anti-Angiogenic Treatment with Chemotherapy Tumor- Immune Interactions under chemotherapy and combination of chemotherapy with Immunotherapy.

An energetic James Sneyd, from the University of Auckland in New Zealand, ended the plenary lecture for the second day. It was remarked that his trip from NZ to Casablanca took over 36 hours! The focus of the talk was on calcium signaling in two distinct cell types, salivary glands and airway smooth muscle cells. In the salivary gland, it was described that calcium controls how chlorine and potassium are moving in and out of the cell, which then controls the volume of the cell and the amount of saliva that is excreted. Through the development of a calcium model in the salivary gland, the presence of certain channels was predicted and then was later confirmed in experiments. The second half of the talk focused on asthma and multiscale modeling efforts that have been undertaken to understand this disease. The contraction of smooth muscle cells in the airways is calcium dependent. Prof. James Sneyd and his international collaborators have developed models of the individual airway smooth cell, as well as multiscale models of the lung in order to understand certain features of asthma.

Prof. Helen Byrne, from the University of Oxford, began the morning session on Wednesday (third day). Her talk focused on two different types of cancer modeling efforts by her research group and what they have learned from each other. The first was multiphase models, where different phases such as cells and fluid can be represented as cell volume fractions. These models can accurately account for tumor growth and account for the biomechanics of tumor growth. In the second half of the talk, Prof. Byrne discussed multiscale models that accounted for the dynamics of each of the individual cells within the tumor. In these models, many of the parameters can be related directly to experimentally measured values. Her talk brought great insight into the current modeling approaches that can be used to model tumor development and treatment strategies.

Prof. Jean Clairambault, from INRIA & INSERM in Paris, gave the last plenary lecture of the conference. The main focus of this talk was on the cell cycle and what goes wrong in cancer. He summarized a number of models that were either coupled systems of PDEs or ODEs to describe different aspects of the cell cycle and the molecular basis of the circadian periodic control. Due to this periodic control, Prof. Clairambault described a mathematical analysis for optimal dosing strategies to treat specific types of cancer.

The first three days of the Casablanca meeting also included three concurrent sessions of contributed and invited talks by junior scientist, a round table and

Participants touring Hassan II Mosque

a poster session. These presentations covered fields from cancer modeling, disease modeling, and other Mathematical Biology topics in general. The fourth and fifth days' events in the Ben M'Sik campus were allocated for workshop lectures, and were given by Profs. Jean Clairambault, Saber Elaydi, Helen Byrne, Eli Fenichel, and Van Savage.

Prof. Jean Clairambault opened the workshop lecture series by his presentation on "Designing Theoretical Therapeutic Optimization Procedures with Toxicity Constraints in Oncology using ODE and PDE Cell Population Dynamic Models". In his lecture, he highlighted the results on the optimization of a chronotherapy delivered in the general circulation, with targets on two separate cell populations, healthy and tumor.

Prof. Saber Elaydi brought the warm feeling of the "classroom" into his lecture on "Competition Models: Stability, bifurcation, and invariant manifolds", where everyone felt like a student again! "The old fashioned way of black board and chalk" definitely made mathematicians feel very welcome!

Prof. Helen Byrne presented an elegant lecture on simple continuum models that have been developed to describe the progress of avascular tumor growth, under the simplifying assumption of radial symmetry.

Prof. Eli Fenichel from Arizona State University kicked off day two of the workshop with an interesting spin on how mathematicians can use ideas from economics to study and model biological systems. One of the key ideas from economics is the idea of tradeoffs. An example that was used was fisheries management. Using dynamic programming, one can determine an optimal solution given the conditions of the world using calculus of variations and optimal control.

The last speaker of the workshop was Prof. Van Savage from the University of California Los Angeles. The focus of this talk was on neutral theory, metabolic theory, food webs, and competitive exclusion. A closer look was taken at several models, with a focus on body size and body-size ratios. Through deriving ways to describe these phenomena, trends of large datasets were reproduced. Within the predator prey framework, Van also emphasized the importance of accounting for foraging and the dimensionality in the system.

These "classroom" like lectures were excellent and engaged a great deal of discussion among the audience, creating dynamic interactions with reputable researchers in the field of Mathematical Biology. We learned great deal from all of the experts! Thank you!

One aspect that the participants of the Casablanca conference will not forget is the social program, which included a tour to the famous Hassan II Mosque, Old Medina & Ain Diab beach, excursion to Rabat (Moroccan Capital) and the amazing and mesmerizing dinner gala at an historic royal palace. As conference participants entered the building, we were greeted with Moroccan musicians and singers, playing local favorites. Within the building, participants were amazed by all of the tile work and the beautiful courtyards. Before the dinner, many participants danced in the courtyard. The dinner was an amazing feast in such a beautiful location where seafood pastilla and delicious lamb with cumin were served.

With all the interesting topics of the talks and the social events, the participants thoroughly enjoyed every aspect of the Casablanca workshop. The organizers got very positive feedback from the participants who expressed interest in similar meetings in the near future.

On behalf of all participants, we would like to thank all of the speakers for their outstanding talks. We would also like to thank the organizers, for their guidance, assistance, and unmatched hospitality.

Finally, we would like to acknowledge the financial support of the Society for Mathematical Biology that helped made the trip to Casablanca possible!

A detailed description of the Casablanca workshop including the plenary and workshop lectures can be found here: https://sites.google.com/a/asu.edu/cicwmb/home

Participants dancing to the vivacious and irresistible Moroccan beats